HANDBOOK

OF

CHEMISTRY AND PHYSICS

A READY-REFERENCE BOOK OF CHEMICAL AND PHYSICAL DATA

FORTY-FOURTH EDITION

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IN COLLABORATION WITH A LARGE NUMBER OF PROFESSIONAL CHEMISTS AND PHYSICISTS WHOSE ASSISTANCE IS ACKNOWLEDGED IN THE LIST OF GENERAL COLLABORATORS AND IN CONNECTION WITH THE PARTICULAR TABLES OR SECTIONS INVOLVED.

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PREFACE

THE Handbook of Chemistry and Physics, continuing the policy of the past, is being revised at frequent intervals.

The general features and scheme of arrangement, which have received extensive endorsement in former editions have been retained. The aim throughout has been to present in condensed form as large an amount of accurate, reliable and up-to-date information in the fields of chemistry and physics as was consistent with convenience in form and the possibility of wide utility and distribution. A very large proportion of the tables have been compiled especially for the Handbook from various authoritative collections of data and from the current journals.

Since the beginning special consideration has been given to the requests and suggestions of those who have used former editions. In this way it has been hoped to develop the book along lines most acceptable to those interested in a volume of this type. Suggestions and contributions are received each year from many eminent chemists and physicists including members of the teaching profession and those engaged in industrial work. We believe this cooperation to have been of very great value in the growth and development of the work.

An attempt has been made to include material on all branches of chemistry and physics and the closely allied sciences, which would be likely to find any extended use. On the other hand, in order to retain the convenience of moderate dimensions and at the same time allow for natural growth due to the extension of knowledge in these sciences, and logical additions along lines already developed, it has seemed necessary to exclude types of material of use only in certain highly specialized lines of work.

Chemistry and physics, always closely related sciences, have been brought into much more intimate relations by the more recent developments of research. To an increasing extent the student of either science should have a knowledge of the other. It would seem that there should be a large field for a single volume containing the constants and formulæ of the two sciences together with mathematical and conversion tables adequate for accurate computation. The generous response which the previous editions have met indicates that the volumes have been found useful and it is with the hope of even more completely meeting the needs of the chemists and physicists of the English speaking world that succeeding editions are offered.

CHARLES D. HODGMAN

LOWERING OF VAPOR PRESSURE BY SALTS IN AQUEOUS SOLUTIONS (Continued)

Substance	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10.0
$MgBr_2$	17.9	44.0	115.8	205.3	298.5				
$MgH_2(SO_4)_2$	18.3	46.0	116.0						
$MnSO_4$	6.0	10.5	21.0						
$MnCl_2$	15.0	34.0	76.0	122.3	167.0	209.0			
NaH_2PO_4	10.5	20.0	36.5	51.7	66.8	82.0	96.5	126.7	157.1
$NaHSO_4$	10.9	22.1	47.3	75.0	100.2	126.1	148.5	189.7	231.4
$NaNO_3$	10.6	22.5	46.2	68.1	90.3	111.5	131.7	167.8	198.8
$NaClO_3$	10.5	23.0	48.4	73.5	98.5	123.3	147.5	196.5	223.5
$(NaPO_3)_6$	11.6								
NaOH	11.8	22.8	48.2	77.3	107.5	139.1	172.5	243.3	314.0
$NaNO_2$	11.6	24.4	50.0	75.0	98.2	122.5	146.5	189.0	226.2
Na_2HPO_4	12.1	23.5	43.0	60.0	78.7	99.8	122.1		
$NaHCO_3$	12.9	24.1	48.2	77.6	102.2	127.8	152.0	198.0	239.4
Na_2SO_4	12.6	25.0	48.9	74.2					
NaCl	12.3	25.2	52.1	80.0	111.0	143.0	176.5		
$NaBrO_3$	12.1	25.0	54.1	81.3	108.8	136.0			
NaBr	12.6	25.9	57.0	89.2	124.2	159.5	197.5	268.0	
NaI	12.1	25.6	60.2	99.5	136.7	177.5	221.0	301.5	370.0
$Na_4P_2O_7$	13.2	22.0							
Na_2CO_3	14.3	27.3	53.5	80.2	111.0				
$Na_2C_2O_4$	14.5	30.0	65.8	105.8	146.0				
Na_2WO_4	14.8	33.6	71.6	115.7	162.6				
Na_3PO_4	16.5	30.0	52.5						
$(NaPO_3)_3$	17.1	36.5							
NH_4NO_3	12.8	22.0	42.1	62.7	82.9	103.8	121.0	152.2	180.0
$(NH_4)_2SiFl_6$	11.5	25.0	44.5						
NH_4Cl	12.0	23.7	45.1	69.3	94.2	118.5	138.2	179.0	213.8
NH_4HSO_4	11.5	22.0	46.8	71.0	94.5	118.	139.0	181.2	218.0
$(NH_4)_2SO_4$	11.0	24.0	46.5	69.5	93.0	117.0	141.8		
NH_4Br	11.9	23.9	48.8	74.1	99.4	121.5	145.5	190.2	228.5
NH_4I	12.9	25.1	49.8	78.5	104.5	132.3	156.0	200.0	243.5
$NiSO_4$	5.0	10.2	21.5						
$NiCl_2$	16.1	37.0	86.7	147.0	212.8				
$Ni(NO_3)_2$	16.1	37.3	91.3	156.2	235.0				
$Pb(NO_3)_2$	12.3	23.5	45.0	63.0					
$Sr(SO_3)_2$	7.2	20.3	47.0						
$Sr(NO_3)_2$	15.8	31.0	64.0	97.4	131.4				
$SrCl_2$	16.8	38.8	91.4	156.8	223.3	281.5			
$SrBr_2$	17.8	42.0	101.1	179.0	267.0				
$ZnSO_4$	4.9	10.4	21.5	42.1	66.2				
$ZnCl_2$	9.2	18.7	46.2	75.0	107.0	153.0	195.0		
$Zn(NO_3)_2$	16.6	39.0	93.5	157.5	223.8				

VAPOR PRESSURE OF NITRIC ACID

Temperature °C	Vapor Pressure, mm. of Hg	
	100 % HNO_3	90 % of HNO_3
0	14.4	5.5
10	26.6	11.
20	47.9	20.
30	81.3	37.3
40	133.	64.4
50	208.	107.
70	467.	242.
80	670.	352.
90	937.	504.
100	1282.	710.

HEAT CONDUCTIVITY

Giving the quantity of heat in calories which is transmitted per second through a plate one centimeter thick across an area of one square centimeter when the temperature difference is one degree Centigrade.

METALS

Substance	Temp. ° C.	Conductivity	Observer
Aluminum	−160	0.514	Lees, 1908
	18	0.480	Jaeger & Diesselhorst, 1900
	18	0.504	Lees, 1908
	100	0.492	Jaeger & Diesselhorst, 1900
	100	0.49	Angell, 1911
	200	0.55	"
	300	0.64	"
	400	0.76	"
	600	1.01	"
Antimony	0	0.0442	Lorenz, 1881
	100	0.040	"
	0–30	0.042	Berget, 1890
Bismuth	−186	0.025	Macchia, 1907
	0	0.0177	Lorenz
	18	0.0194	Jaeger & Diesselhorst, 1900
	100	0.0161	Jaeger & Diesselhorst, 1900
Brass (70Cu+30Zn)	−160	0.181	Lees, 1908
(70Cu+30Zn)	17	0.260	" "
yellow	0	0.204	Lorenz
red	0	0.246	"
Bronze, aluminum (90Cu, 10Al)	.....	0.18	Van Aubel
Cadmium	−160	0.239	Lees, 1908,
	0	0.220	Lorenz
	18	0.222	Jaeger & Diesselhorst, 1900
	100	0.216	Jaeger & Diesselhorst, 1900
Constantan	18	0.054	Jaeger & Diesselhorst, 1900
(60Cu, 40Ni)	100	0.064	Jaeger & Diesselhorst, 1900
Copper, pure	−160	1.097	Lees, 1908
	13	1.00	Angström, 1863
	18	0.918	Jaeger & Diesselhorst, 1900

THERMAL CONDUCTIVITY OF DIELECTRIC CRYSTALS

Name	Remarks	Conductivity mw/cm deg K	
		83° K	273° K
Marble	Small crystals, 99.9 % $CaCO_3$	42	33
Do	99.99 % $CaCO_3$	54	38
Do	Large crystals	50	33
Calcite	Main crystal axis perpendicular to rod axis.	180	46
Do	Main crystal axis parallel to rod axis.	293	54
Sylvite	Natural crystal	159	75
KCl	Pressed at 8,000 atm	314	88
KCl	From a melt	402	92
NaCl	do	343	92
NaCl	Pressed at 8,000 atm	251	71
Rock salt	do	180	63
Sylvite	do	343	84
KCl	Pressed at 1,250 atm	243	75
KCl	Pressed at 2,500 atm	368	92
KCl	Pressed at 8,900 atm	402	96
KBr	Pressed at 8,000 atm	92	38
NaBr	do	50	25
KI	do	121	29
KF	do	234	71
NaF	do	519	105
RbI	do	59	33
RbCl	do	29	21
90 % KBr, 10 % KCl	do	50	29
75 % KBr, 25 % KCl	do	29	21
50 % KBr, 50 % KCl	do	25	25
25 % KBr, 75 % KCl	Pressed at 8,000 atm	46	33
10 % KBr, 90 % KCl	do	80	50
50 % KCl, 50 % NaCl	do	188	71
KNO_3	do	17	21
Mercuric chloride	do	17	13
NH_4Cl	do	109	25
NH_4Br	do	67	25
$Ba(NO_3)_2$	do	33	13
Copper sulfate		29	21
Magnesium sulfate		25	25
$K_4Fe(CN_6)$		17	17
Chrom alum		13	21
Potassium alum		13	21
Potassium bichromate	Main crystal axis perpendicular to rod axis.	17	21
Do	Main crystal axis parallel to rod axis.	17	17
Topaz	Mineral		234
Zincblend	do	63	264
Beryll	do	88	84
Tourmaline	do	38	46

HEAT CONDUCTIVITY (Continued)

Various Solids

Approximate values at ordinary temperatures.

Substance	Conductivity	Observer
Asbestos fiber, 500° C	0.00019	Randolph, 1912
paper	0.0006	.....
	0.0004	Lees-Chorlton, 1896
Basalt	0.0052	Hecht, 1903
Brick, common red	0.0015	Herschel-Lebour & Dunn, 1879
Blotting paper	0.00015	Lees-Charlton, 1896
Carbon	0.01	
Carborundum	0.0005	Lorenz
brick, 150°–1200°	0.032–0.027	Wologdine
Cardboard	0.0005	.....
Cement, Portland	0.00071	Lees-Chorlton, 1896
Chalk	0.0020	Herschel-Lebour & Dunn, 1879
Concrete, cinder	0.00081	.....
stone	0.0022	Norton
Cork	0.00072	G. Forbes, 1875
	0.00013	Lees, 1892–8
Cotton wool	0.000043	G. Forbes
felted	0.000033	"
Diatomic earth	0.00013	Hutton-Blard
Earth's crust, ave	0.004	.....
Ebonite	0.00042	Lees
	0.00014	Barratt, 1914
Eiderdown, d = .109	0.000046	Peclet, 1878
Felt	0.000087	.....
Fiber, red	0.0011	Barratt, 1914
Fire brick	0.00028	Hutton-Blard
	0.0011	Barratt, 1914
Flannel	0.00023	
Gas carbon, 20°	0.0085	Barratt, 1914
100°	0.0095	"
Glass		
crown (window)	0.0025	Lees, 1892–8
flint	0.002	"
Jena	0.001–0.002	"
soda, 20°	0.0017	Barratt, 1914
100°	0.0018	"
Granite, 100°	0.0045–0.0050	Poole, 1912
500°	0.0040	"
Graphite	0.012	.....
Graphite brick, 300° to 700°	0.24	Wologdine, 1909